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Novel concepts of resonators for beam structures

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Abstract: Beam structures equipped with resonators are common in structural and mechanical engineering applications. In general, they are represented as a continuous-discrete system where a continuous 1D Euler or Timoshenko beam is coupled with discrete mass-spring subsystems modelling single-degree-of-freedom (SDOF) or multi-degree-of-freedom (MDOF) resonators. Typical resonators are activated by beam deflection and vibrate transversely to the beam axis. The paper aims to introduce novel concepts of MDOF resonators, featuring multiple degrees of freedom in transverse as well as lateral directions relative to the beam axis, to be activated by beam deflection at the attachment point. It will be shown that the novel MDOF resonators can be reverted to equivalent external constraints, with reaction depending only on the beam deflection at the attachment point through a suitable frequency-dependent stiffness. On this basis, the coupled motion equations of the continuous-discrete system will be solved using the motion equation of the beam only, obtaining frequency and time responses under arbitrary loads by a generalized function approach: the frequency response will be derived by direct integration of the motion equation of the beam, while modal frequency and impulse responses will be built by complex modal superposition. Frequency response and modal responses will be calculated in exact analytical form, for any number of resonators. The paper will investigate the dynamics of beams equipped with the novel MDOF resonators and show the advantages of the proposed analytical framework.

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